



Precision Monolithics Inc.

## APPLICATION BRIEF 108

# AB-108

## A MICROPOWER SINGLE-SUPPLY PRECISION RECTIFIER

This precision full-wave rectifier circuit accepts AC inputs of up to  $\pm 3V$ , yet operates from a single +5V supply voltage. Quiescent supply drain is only  $320\mu A$ . Rectifier gain is unity with the gain accuracy almost entirely dependent on the match between resistors  $2R_1$  and  $2R_1$ . Frequency range is approximately DC to 2kHz. The single supply operation at very low, quiescent current drain makes this circuit particularly useful for battery-powered equipment.

For positive input voltage ( $V_{IN} > 0$ ), A1 will drive Q1 and D2 to make the output voltage  $V_O$  equal to the input voltage. Output swing at  $V_O$  is approximately three diode drops below the supply voltage, thus the peak output voltage is near +3V. Amplifier A2 output goes to negative saturation, which is approximately +0.8V, and Q2 will therefore be back-biased and OFF.

For negative input voltage ( $V_{IN} < 0$ ), A1 output goes into negative saturation and Q1 is thereby gated OFF. Amplifier A2 will serve as a unity-gain inverter. Since  $V_O$  will be equal to  $V_{IN}$  in magnitude, but opposite in polarity,  $V_O$  will be equal to the absolute value of  $V_{IN}$ .

Quiescent current drain is determined by the set current  $I_{SET}$ . With a 5V supply the set current will be  $3.7V/R_{SET}$ . Slew rate and bandwidth vary directly with the set current. Amplifier A1 essentially operates with unity-gain feedback, while A2 operates with a feedback gain of 0.5. The closed-loop gain-bandwidth is therefore made equal, and the frequency response symmetrical, by making the set current of A2 twice that of A1. Amplifier A2 has a set current of  $3.7V/200k$ , which is  $18.5\mu A$ , and amplifier A1 has a set current of  $3.7V/390k$ , which is  $9.5\mu A$ . These set currents will result in quiescent currents of  $100\mu A$  for amplifier A1 and  $220\mu A$  for amplifier A2.

The OP-22 input stage is a PNP Darlington, thus a negative input voltage can forward bias the collector-base junction of the input transistor. This potential problem is prevented by adding resistor R1 and diode D1 at the A1 input to limit the negative input voltage.

This simple circuit provides precise, unity-gain rectification of AC signals of up to  $\pm 3V$  in the frequency range of DC to 2kHz. It operates from a single +5V supply voltage with quiescent current drain of only  $320\mu A$ .

